

# A GENERIC INTERFACE BETWEEN COSMIC/NASTRAN AND PATRAN

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## SUMMARY

Despite its powerful analytical capabilities, COSMIC/NASTRAN lacks adequate post-processing adroitness. PATRAN<sup>1</sup>, on the other hand is widely accepted for its graphical capabilities. A nonproprietary, public domain code mnemonically titled CPI (for COSMIC/NASTRAN-PATRAN Interface) is designed to manipulate a large number of files rapidly and efficiently between the two parent codes. In addition to PATRAN's results file preparation, CPI also prepares PATRAN's P/PLOT data files for xy plotting. The user is prompted for necessary information during an interactive session. Current implementation supports NASTRAN's displacement approach including the following rigid formats: (1) static analysis, (2) normal modal analysis, (3) direct transient response, and (4) modal transient response. A wide variety of data blocks are also supported. Error trapping is given special consideration. A sample session with CPI illustrates its simplicity and ease of use.

## INTRODUCTION

### Overview

The standard gateway that interfaces COSMIC/NASTRAN's analysis results to PATRAN's post-processing makes use of NASTRAN's FORTRAN-written results files. These files can be requested via DMAP ALTER's OUTPUT2 statement in NASTRAN's executive data deck. They contain data in mixed ASCII and binary code format. However, they can not be used as direct input to PATRAN. Similarly, PATRAN also supports communications with external codes via specially formatted results files. Format of these files is predetermined according to PATRAN and differs for each data type. Generally, they can be categorized into three groups according to their formats: (1) nodal results files, (2) element results files, and (3) beam results files. The number of results files can be as many as required. Therefore, in order to interface COSMIC/NASTRAN to PATRAN for post-processing purposes, an interface that is capable of translating from NASTRAN's analysis results to PATRAN-recognizable files is required.

Fig. 1 shows code and file relationships among the analysis and post-processing modules. The flow begins with the input of NASTRAN's analysis data deck. DMAP ALTER statements must be included in the executive control deck in order to obtain a FORTRAN-written results file. Generally, this file is assigned an extension of .PAT. This NASTRAN results file is then translated by the COSMIC/NASTRAN-PATRAN Interface (CPI). Output from CPI is a group of PATRAN-compatible results files and/or a P/PLOT-compatible data file. These files are ready for PATRAN post-processing.

<sup>1</sup> PATRAN is a trademark of PDA Engineering

PATRAN also requires access to a neutral file containing geometrical properties of the model. This file can be obtained via the COSPAT<sup>2</sup> translator, but not by means of CPI.

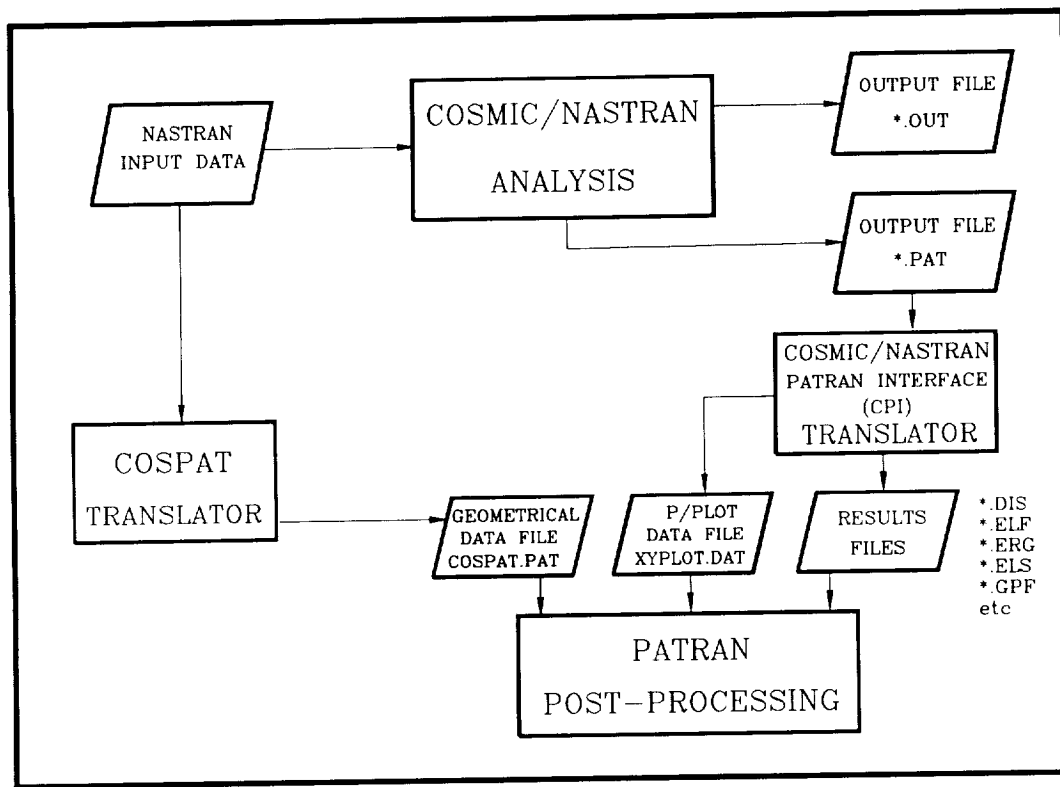


Fig. 1 Code and File Relationships

## Program Description

COSMIC/NASTRAN-PATRAN Interface (CPI) translates COSMIC/NASTRAN's FORTRAN-written results files to PATRAN compatible results files. These results files can be requested via the OUTPUT2 instruction in the executive control deck. CPI provides the operation in two modes:

**Mode 1 - Whole Model Translation:** CPI translates all data blocks contained in the NASTRAN results file (\*.PAT) and creates PATRAN compatible results files corresponding to data blocks found in the input data file. The user is prompted for the prefix name of an output file. Different prefixes allow the user to distinguish between groups of output files when many results files are translated in a single execution. Up to 6 characters per prefix is acceptable. Created output files and translated data blocks are summarized on the screen during CPI's execution.

**Mode 2 - XY-Plot Data Preparation:** CPI creates data for the specified node or element from a set of data blocks. CPI prompts the user for necessary information, i.e. node number and component number for nodal data, and searches the input file for any data on

<sup>2</sup> COSPAT is a COSMIC/NASTRAN to PATRAN interface, developed by COSMIC, University of Georgia, Athens, Georgia.

this node. Each data set is written to PATRAN's P/PLOT compatible data file. CPI names this file XYPLOT.DAT. When this command is selected, CPI automatically reviews the data blocks available in the current input file. The user is then prompted to enter the number corresponding to the data block name shown above this prompt.

Currently, CPI supports NASTRAN's displacement approach including, but not limited to, the following rigid formats:

- (1) Static Analysis (Rigid Format 1)
- (2) Normal Modal Analysis (Rigid Format 3)
- (3) Direct Transient Response (Rigid Format 9)
- (4) Modal Transient Response (Rigid Format 12)

Table 1 shows data blocks supported by CPI. It should be noted that CPI supports any rigid format as long as the data blocks listed are encountered. Rigid formats named above are only a guide to the rigid formats most frequently giving rise to these data blocks. CPI recognizes data blocks, not rigid formats. Table 2 shows elements currently supported by CPI.

**Table 1. Data Blocks Supported by CPI**

Data Block	Content
OUGV1	Nodal Displacements
HOUGV1	Nodal Temperature
OQG1	Single Point Constraint
OPG1	Load Vectors
OPHIG	Eigenvectors
OUPV1	Displacement Vectors
ONRGY1	Strain Energy
OES1(X)	Element Stress
OEF1	Element Forces
OGPFB1	Grid Point Balance Forces

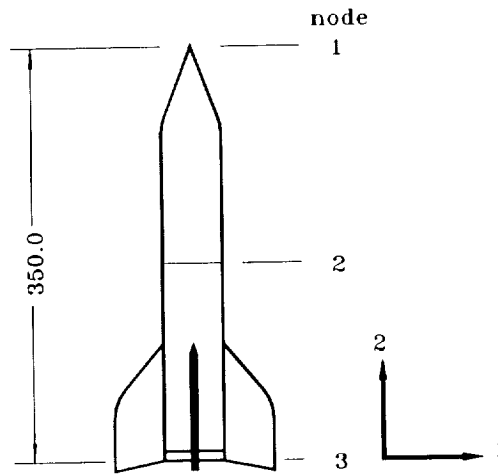
**Table 2. Elements Supported by CPI**

Element Name	ID Number	Element Name	ID Number
CROD	1	CQDPLT	15
CQDMEM2	63	CBEAM	2
CTRIA2	17	CTUBE	3
CQUAD2	18	CTRIA1	6
CQUAD1	19	CTRBSC	7
CBAR	34	CTRPLT	8
CTRIARG	36	CTRMEM	9
CTRAPRG	37	CONROD	10
CQDMEM1	62	CTETRA	39
CWEDGE	40	CHEXA1	41
CHEXA2	42	CIHEX1	65
CIHEX2	66	CIHEX3	67

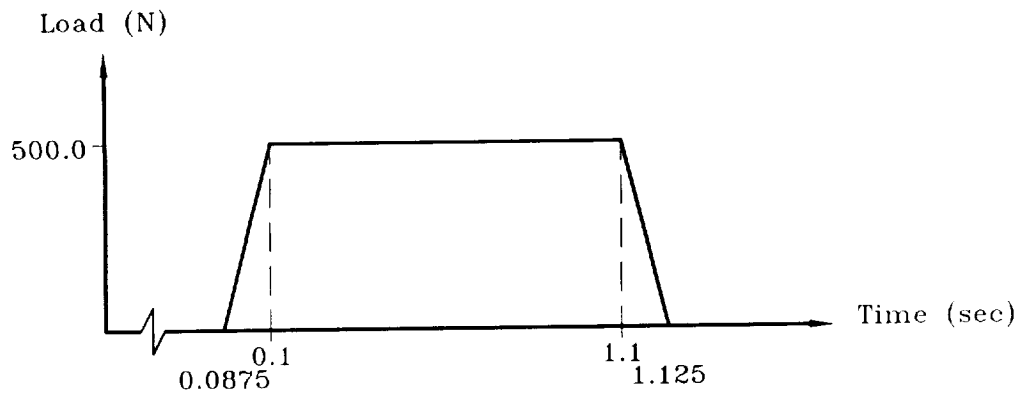
## PROGRAM USAGE AND SAMPLE SESSION

COSMIC/NASTRAN-PATRAN INTERFACE (CPI) is an interactive program. A user can manipulate the program by selecting from menu commands and answering questions. No special commands are needed. CPI also provides extensive error trapping to ensure appropriate input and output.

The following sample session (adapted from Ref. 5) illustrates execution of CPI for transient dynamic analysis results in which a series of time steps is involved. A simple three node model which is 350 cm. high, and has a cross sectional area of  $6.45 \text{ cm}^2$  (see Fig. 2), is used to model a rocket trajectory. Time versus loading of the rocket is shown in Fig. 3.



**Fig. 2 Sample 2 - Geometric Properties**



**Fig. 3 Sample 2 - Load vs. Time**

After invocation, CPI's opening header appears on the screen and CPI prompts the user for the name of the NASTRAN results file to be translated. The user then enters the NASTRAN results file name with its extension. Alternatively, the user can leave the translator and return to the operating system by entering "EXIT" (or "exit" or "E" or simply "e"). Here, the NASTRAN results file name is assigned the name "ROCKET.PAT."

```

*****
**                                     **
**          COSMIC/NASTRAN - PATRAN INTERFACE          **
**                                     **
**          ** C P I **          **
**                                     **
**          TEXAS A&M UNIVERSITY          **
**          &          **
**          TEXAS INSTRUMENTS          **
**                                     **
**          (JUNE 1989)          **
**                                     **
*****

```

```

ENTER NASTRAN RESULTS FILE NAME OR "EXIT"
>ROCKET.PAT

```

Once the results file has been named, CPI reads the results file header and echoes it to the screen for verification. Next a menu and a prompt for selection appear on the screen. The response to CPI should be one of the following:

- > 1 Select 1 to translate the entire file and create appropriate PATRAN-compatible results files.
- > 2 Select 2 to translate the data and create PATRAN's P/PLOT-compatible data files which contain requested nodal or element data.
- > 3 Select 3 to specify a new NASTRAN results file.
- > 4 Select 4 to exit CPI and return to the operating system.

If the first option is chosen, translation proceeds as follows:

```

DATE   : 7/27/89
HEADER: NASTRAN FORT TAPE ID CODE -
LABEL  : XXXXXXXX

```

```

-----
>>>>>> ENTER YOUR SELECTION <<<<<<
-----

```

- 1) WHOLE MODEL TRANSLATOR
- 2) XY-PLOT DATA
- 3) ENTER NEW RESULTS FILE
- 4) EXIT

```

> 1
ENTER FILENAME PREFIX (UP TO 6 CHARACTERS) OR [RETURN]
(EXAMPLE DEFAULT FORMAT: S_I_.DIS)
> ROCKET
IS "ROCKET" THE CORRECT PREFIX? [Y]
><RETURN>

```

FILE CREATED	FROM DATA BLOCK
ROCKETS01I1.DIS	OUPV1
ROCKETS01I2.DIS	OUPV1
ROCKETS01I3.DIS	OUPV1
"	"
"	"
"	"
ROCKETS01I50.DIS	OUPV1
ROCKETS01I51.DIS	OUPV1

-----

>>>>>> ENTER YOUR SELECTION <<<<<<<

-----

- 1) WHOLE MODEL TRANSLATOR
- 2) XY-PLOT DATA
- 3) ENTER NEW RESULTS FILE
- 4) EXIT

>

At this point the entire model is translated with the creation of the 51 files shown on the screen during execution. Each file corresponds to a new time step and a new geometric location of the rocket. It is apparent that running each file with PATRAN to obtain specific data for a given node and component can become tedious. Therefore, a routine has been incorporated into CPI to allow the user to create a file that contains only user-specified data available for plotting with P/PLOT.

When the second option is chosen, CPI reviews data block names existing in the current results file. The user is asked to select a data block name. CPI classifies data blocks into two groups: (1) nodal data, and (2) element data. If the selected data block contains nodal data, CPI prompts for a node number and a component number (1-6). In general, the six components of nodal data are:

- Component 1: X-direction translation vector
- Component 2: Y-direction translation vector
- Component 3: Z-direction translation vector
- Component 4: X-direction rotational vector
- Component 5: Y-direction rotational vector
- Component 6: Z-direction rotational vector

If the selected data block is an element data block, the user is prompted for an element number and a column number.

Next, CPI searches for the requested data and, upon completion of gathering the data, requests a data header extension of the current XY-plot data. Up to 38 characters is acceptable. Execution proceeds as follows:

```

-----
>>>>>> ENTER YOUR SELECTION <<<<<<
-----

      1) WHOLE MODEL TRANSLATOR
      2) XY-PLOT DATA
      3) ENTER NEW RESULTS FILE
      4) EXIT
> 2

-----
      DATA BLOCK REVIEW
-----

      1) OUPV1
-----

ENTER DESIRED BLOCKNAME NUMBER
(OR "0" TO EXIT)
> 1
ENTER NODE NUMBER
> 2
WHICH COMPONENT (1-6)?
> 2
ENTER PLOT TITLE EXTENSION FOR DATA SET: 1
DEFAULT TITLE: YDATA, DATA SET: 1; NODE: 2; COMPONENT:
2-
> Y-TRAJECTORY OF ROCKET
      %%% NUMBER OF DATA WRITTEN = 51 %%%

-----
      DATA BLOCK REVIEW
-----

      1) OUPV1
-----

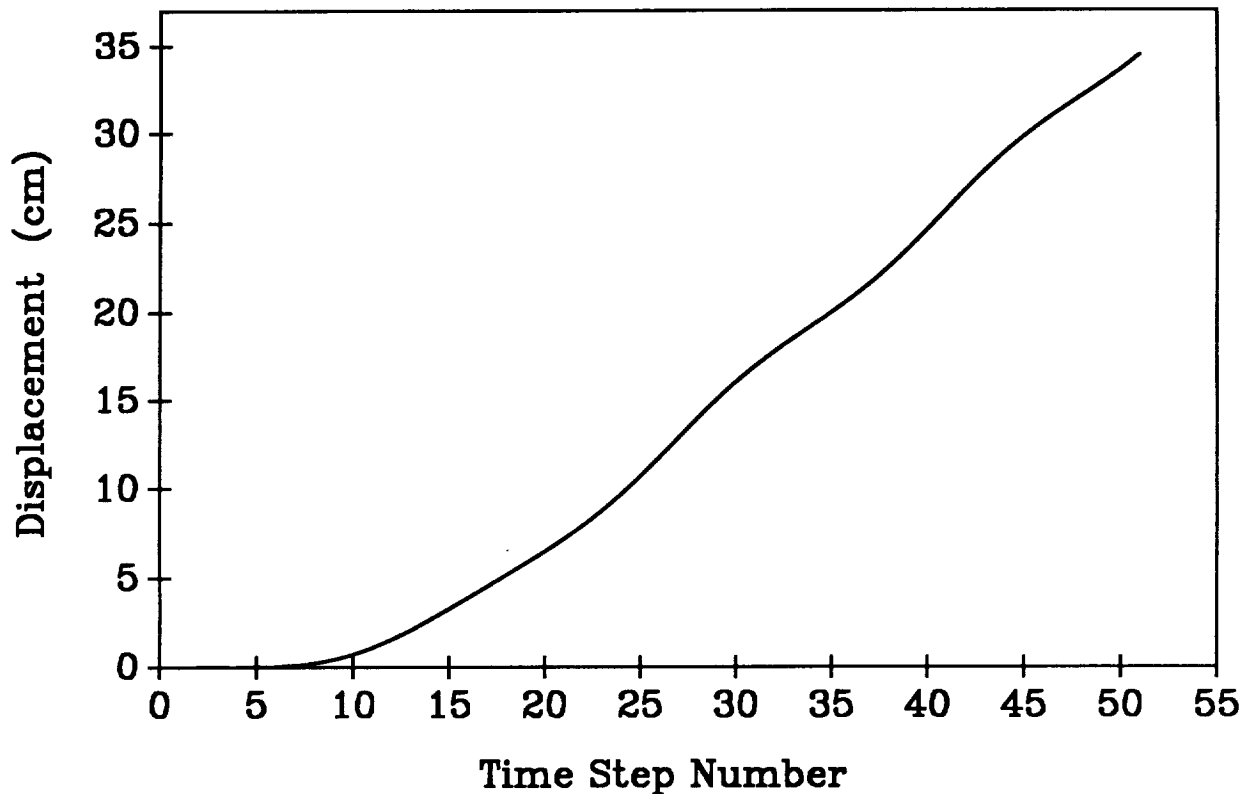
ENTER DESIRED BLOCKNAME NUMBER
(OR "0" TO EXIT)
> 0

-----
>>>>>> ENTER YOUR SELECTION <<<<<<
-----

      1) WHOLE MODEL TRANSLATOR
      2) XY-PLOT DATA
      3) ENTER NEW RESULTS FILE
      4) EXIT
> 4
CPI Execution Completed

```

At this point a file called XYPLOT.DAT exists and upon input of this file into P/PLOT, data is readily graphed for the Y coordinates (component 2) of node 2 of the rocket for each of the 51 time steps (Fig. 4).



**Fig. 4 Displacement of Node 2 - Component 2**

## **OUTPUT FILES**

### **Results Translation**

CPI creates several results files which provide a direct avenue between COSMIC/NASTRAN's analysis algorithms and PATRAN's post-processing capabilities. COSMIC/NASTRAN's input file (commonly called the input data deck) provides the name of a binary file which CPI interpolates. For example, EXAMPLE.NAS (the input data deck) yields EXAMPLE.PAT (the binary file to be translated to PATRAN-compatible results files). Creation of the binary file is accomplished by inclusion of the appropriate ALTER statement in the executive control deck of COSMIC/NASTRAN's input data deck. Only filename extensions are changed by execution of COSMIC/NASTRAN. EXAMPLE.PAT is then translated by CPI into appropriate PATRAN-compatible results files. A description of each file follows.

All CPI output files are given the name 'XiiInnn.EXT' where X is either an 'S' or an 'M' depending on whether the following two digit number is either a subcase or a mode number, respectively, and EXT is the file extension named with respect to data type.



## XY-Plot

Selecting "XY-PLOT DATA" at CPI's main menu initiates a prompt screen which lists the various data blocks found in COSMIC/NASTRAN's binary output file. CPI then invites the user to specify desired data blocks containing either nodal or element data that are to be written to XYPLOT.DAT, which is the input file for P/PLOT. This file can contain one or more data sets depending on how many times the user requests that CPI write to this file. CPI writes only y-data to XYPLOT.DAT since the user defines an initial x and delta-x when executing P/PLOT. A description of XYPLOT.DAT's format is given below.

### (1) Nodal Data Blocks

The first line written for each data block contains the default title:

**"YDATA, DATA SET: iii; NODE nnnn; COMPONENT j - "**

and may be appended to allow for more descriptive titles. This appendage plus the default title must not exceed 80 characters. If more than 80 characters are specified, those beyond column 80 are truncated. This allows the user a suffix of anywhere from 33 to 38 characters depending on the number of digits contained in the default title.

Each line thereafter, until either a ^Z (end of file) or another title is encountered, contains nodal data for components 1, 2, 3, 4, 5, or 6, i.e., X, Y, Z,  $\theta_x$ ,  $\theta_y$ , or  $\theta_z$ , respectively, as requested from CPI's prompting.

### (2) Element Data Blocks

As with nodal data blocks, the first line written for an element data block contains a default title and takes the form:

**"YDATA, DATA SET: iii; ELEMENT nnnn; COLUMN j - "**

It may also be appended as described above, but again, the default title plus the appendage must not exceed 80 characters in length or truncation of characters beyond column 80 occurs. As with the nodal data case, a suffix of 33 to 38 characters is allowed.

The remaining lines associated with the current data set contain element data available for plotting. The data type is chosen by entry of a column number at CPI's prompt.

## SOFTWARE AND HARDWARE REQUIREMENTS

CPI source code was written in standard FORTRAN 77; however, some special features of VAX/VMS FORTRAN were implemented. CPI will run on any VAX machine with a VMS operating system and a FORTRAN compiler. The total length of the source code is approximately 1200 lines, which requires 104 blocks of disk space.

## REFERENCES

- (1) *NASTRAN User's Manual*, Computing Services Annex, University of Georgia, Athens, Georgia, 1986.
- (2) *NASTRAN Programmer's Manual*, Computing Services Annex, University of Georgia, Athens, Georgia, 1978.
- (3) *PATRAN Plus User Manual*, Release 2.3, PDA Engineering, Costa Mesa, California, 1988.
- (4) Schaeffer, G. H., *MSC/NASTRAN Primer*, Schaeffer Analysis Inc., Mont Vernon, New Hampshire, 1979.
- (5) *MSC/NASTRAN Demonstration Problem Manual*, The Macneal-Schwendler Corporation, Los Angeles, California, 1983.
- (6) Nyhoff, L., Leestina, S., *FORTRAN 77 for Engineers and Scientists*, Macmillan Publishing Company, New York, 1988.